

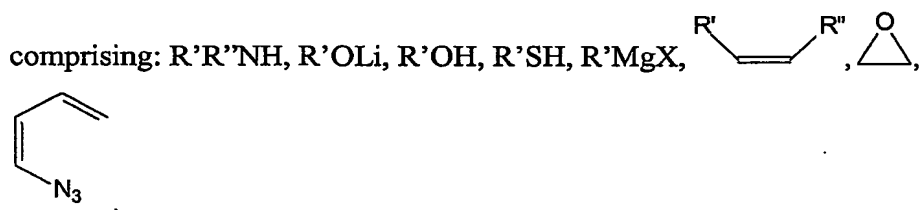
**What is claimed is:**

1. A method for labeling synthesis, comprising:
  - (a) Providing a high pressure reaction chamber having a liquid inlet and a gas inlet in a bottom surface thereof,
  - (b) providing an azide solution to be labeled mixed with a transitional metal complex and a liquid reagent,
  - (c) introducing a carbon-isotope monoxide enriched gas-mixture into the reaction chamber via the gas inlet,
  - (d) introducing at high pressure said azide solution mixed with transition metal complex and liquid reagent into the reaction chamber via the liquid inlet,
  - (e) waiting for a predetermined time while the labeling synthesis occur, and
  - (f) removing the labeled compound from the reaction chamber.
2. A method of claim 1, wherein the carbon-isotope monoxide enriched gas-mixture is produced by a method comprising:
  - (a) providing carbon-isotope dioxide in a suitable carrier gas,
  - (b) converting carbon-isotope dioxide to carbon-isotope monoxide by introducing said gas mixture in a reactor device,
  - (c) trapping carbon-isotope monoxide in a carbon monoxide trapping device, wherein carbon-isotope monoxide is trapped but not said carrier gas, and
  - (d) releasing said trapped carbon-isotope monoxide from said trapping device in a well defined micro-plug, whereby a volume of carbon-isotope monoxide enriched gas-mixture is achieved.
3. A method of claim 1, wherein the carbon-isotope is  $^{11}\text{C}$ ,  $^{13}\text{C}$ , or  $^{14}\text{C}$ .
4. A method of claim 1, wherein the carbon-isotope is  $^{11}\text{C}$ .
5. A method of claim 1, wherein the step of introducing the azide solution to be labeled mixed with a transitional metal complex and a liquid reagent is performed



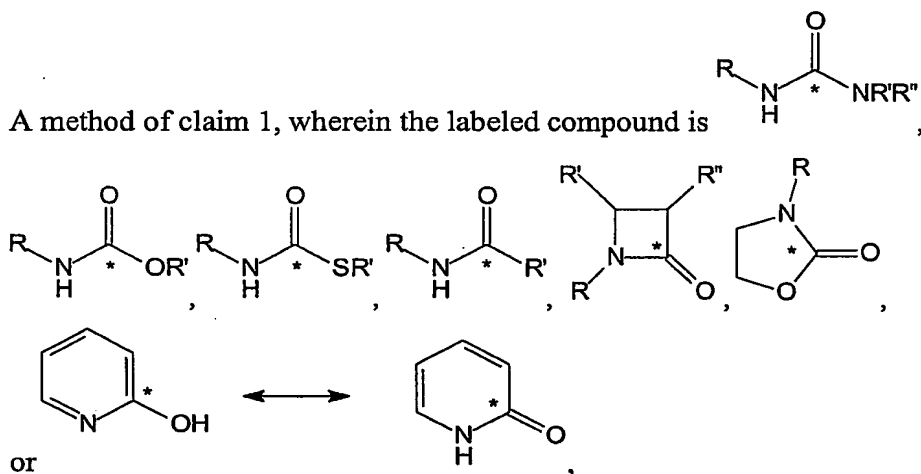
using a pressure that is about 80 times higher than the pressure before the introduction, in order to maintain a pseudo one-phase system.

6. A method of claim 1, wherein the step of waiting a predetermined time comprises adjusting the temperature of the reaction chamber to enhance the labeling synthesis.
7. A method of claim 1, wherein the transitional metal complex is a rhodium complex.
8. A method of claim 1, wherein the liquid reagent is selected from a list



wherein X is selected from Cl, Br, or I, and R' and R'' are independently linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl, and may contain carbonyl, hydroxy, thiol, halogen, nitrile, isonitrile, cyanate, isocyanate, thiocyanate, isothiocyanate functional groups.

9. A method of claim 1, wherein the labeled compound is



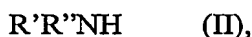
wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl, R' and R'' are independently linear or cyclic lower alkyl or substituted alkyl, aryl or



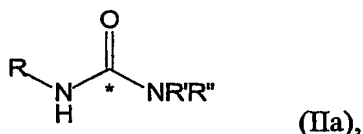
substituted arly, and may contain carbonyl, hydroxy, thiol, halogen, nitrile, isonitrile, cyanate, isocyanate, thiocyanate, isothiocyanate functional groups.

10. A method for radiocarbonylation comprising reaction of carbon-isotope monoxide with a compound of formula  $R-N_3$  to give a carbon-isotope labeled compound of formula  $R-N=C^*=O$ , wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl.

11. A method for radiocarbonylation comprising reaction of carbon-isotope monoxide with a compound of formula (I) and a compound of formula (II):



to give a labeled compound of formula (IIa):

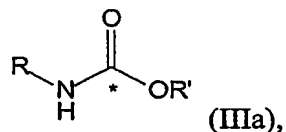


wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl and R' and R'' are independently linear or cyclic lower alkyl or substituted alkyl, aryl or substituted arly, and may contain carbonyl, hydroxy, thiol, halogen, nitrile, isonitrile, cyanate, isocyanate, thiocyanate, isothiocyanate functional groups.

12. A method for radiocarbonylation comprising reaction of carbon-isotope monoxide with a compound of formula (I) and a compound of formula (III):



to give a labeled compound of formula (IIIa):



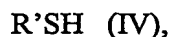
wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl and R' is a linear or cyclic lower alkyl or substituted alkyl, aryl or substituted arly,



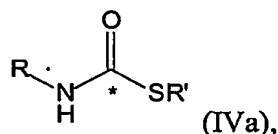
and may contain carbonyl, hydroxy, thiol, halogen, nitrile, isonitrile, cyanate, isocyanate, thiocyanate, isothiocyanate functional groups.



13. A method for radiocarbonylation comprising reaction of carbon-isotope monoxide with a compound of formula (I) and a compound of formula (IV):



to give a labeled compound of formula (IVa):

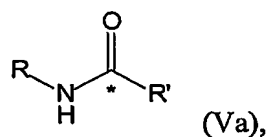


wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl and R' is a linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl, and may contain carbonyl, hydroxy, thiol, halogen, nitrile, isonitrile, cyanate, isocyanate, thiocyanate, isothiocyanate functional groups.

14. A method for radiocarbonylation comprising reaction of carbon-isotope monoxide with a compound of formula (I) and a compound of formula (V):



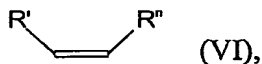
to give a labeled compound of formula (Va):



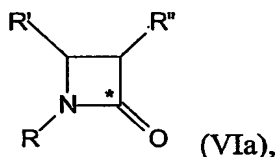
wherein X is selected from Cl, Br, or I, R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl and R' is a linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl, and may contain carbonyl, hydroxy, thiol, halogen, nitrile, isonitrile, cyanate, isocyanate, thiocyanate, isothiocyanate functional groups.



15. A method for radiocarbonylation comprising reaction of carbon-isotope monoxide with a compound of formula (I) and a compound of formula (VI):



to give a labeled compound of formula (VIa):

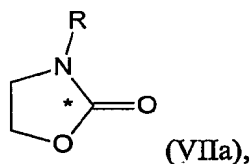


wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl and R' and R'' are independently linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl, and may contain carbonyl, hydroxy, thiol, halogen, nitrile, isonitrile, cyanate, isocyanate, thiocyanate, isothiocyanate functional groups.

16. A method for radiocarbonylation comprising reaction of carbon-isotope monoxide with a compound of formula (I) and a compound of formula (VII):



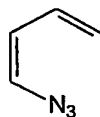
to give a labeled compound of formula (VIIa):



wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl.

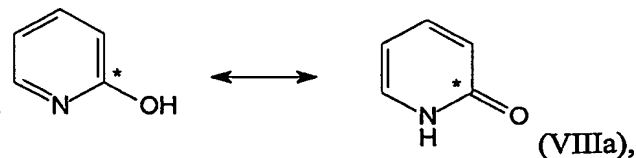


17. A method for radiocarbonylation comprising reaction of carbon-isotope monoxide with a compound of formula (I) and a compound of formula (VIII):



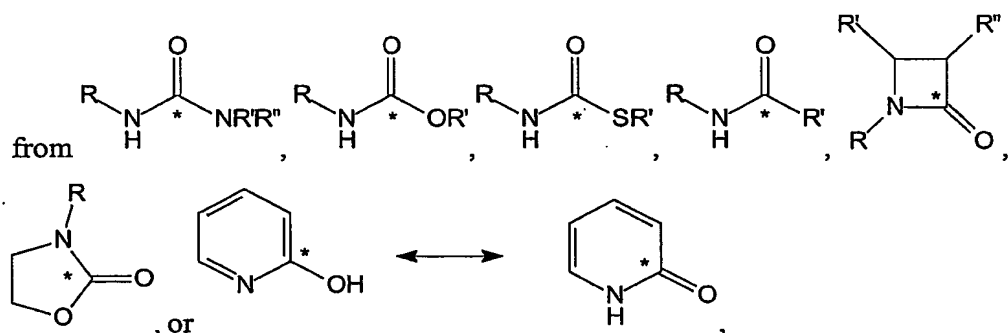
(VIII),

to give a labeled compound of formula (VIIIa):



wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl.

18. A kit for PET study comprising a carbon-isotope labeled compound selected



wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl, R' and R'' are independently linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl, and may contain carbonyl, hydroxy, thiol, halogen, nitrile, isonitrile, cyanate, isocyanate, thiocyanate, isothiocyanate functional groups.

19. A kit of claim 18, further comprising radioprotectant, antimicrobial preservative, pH-adjusting agent or filler.

20. A kit of claim 19, wherein the radioprotectant is selected from ascorbic acid, para-aminobenzoic acid, gentisic acid and salts thereof.



21. A kit of claim 19, wherein the antimicrobial preservative is selected from the parabens, benzyl alcohol, phenol, cresol, cetrimide and thiomersal.
22. A kit of claim 19, wherein the pH-adjusting agent is a pharmaceutically acceptable buffer or a pharmaceutically acceptable base, or mixtures thereof.
23. A kit of claim 19, wherein the filler is inorganic salts, water soluble sugars or sugar alcohols.